Encoding Temporal and Spatial Vessel Context using Self-Supervised Learning Model (Student Abstract)

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Automatic Identification System (AIS)

Automatic Identification System, as a tracking system, supports maritime traffic surveillance and control. Having AIS activated is mandatory for most vessels, especially commercial ones. **An AIS transmitter broadcasts vessel information**, such as its location, speed, or heading to nearby ships, coastal stations, and satellites, **up to every 2 seconds**. These messages can then be collected with ground antennas or satellites.

Dataset

The dataset use in this work, provided by Statsat, is a collection of messages covering all the globe over one month. This data have been captured using 4 satellites.

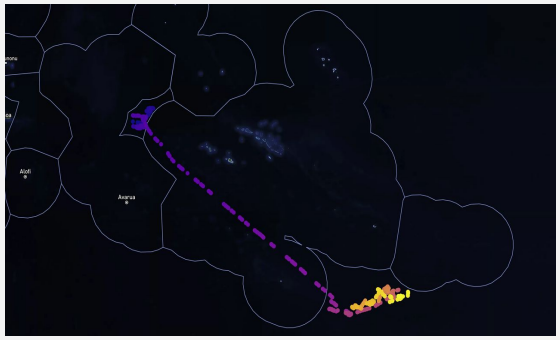

Figure 1: Example vessels' trajectory and messages' irregularity

Challenges

We face multiple challenges in applying machine learning to these data:

- the **varying messages' frequency**,
- the **continually changing situation of the nearby vessels**,
- the **loss of many messages** due to collisions between messages or the limited capacity in the protocol.

AIS Analysis Tasks

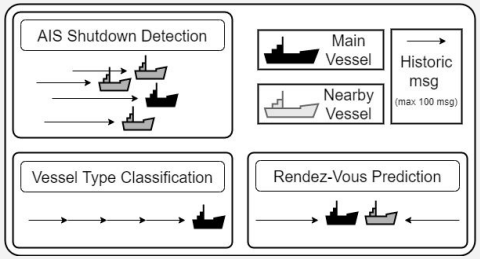

Figure 2: Main tasks used to evaluate the shared representation

Approach

We propose a novel representation learning method that considers **both temporal and spatial contexts learned** in a self-supervised manner, using a selection of pre-text tasks that do **not require to be labeled manually**. The underlying model encodes the representation of maritime vessel data compactly and effectively. This generic encoder can then be used as input for more complex tasks (**Figure 2**) lacking labeled data.

The following steps explain the thinking process of how we came up with our approach:

1. Extracting data to train on the main task can be difficult due to the **rarity of relevant situations in the dataset.**
2. The trajectory of a vessel and its context **require a relatively large model** compared to the data available for the training.
3. The **pre-training task does not require specific situation**, therefore we can use any trajectory to train it. This allows us to pre-train the shared representation on a large dataset.
4. **The representation is then given as input to the main task with a smaller dataset** without having overfitting and with a better understanding of the context.

Method Architecture Overview

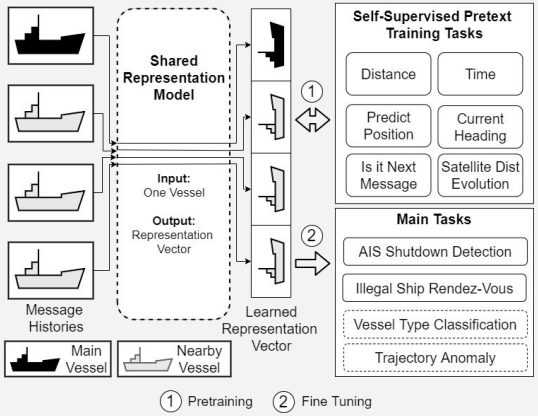

Figure 3: The model is shared between vessels and between tasks

Results

We obtain an accuracy of :

- **92% for AIS shutdown detection,**
- **89.7% for predicting rendez-vous.**

These first results are encouraging considering the wide range of diverse inputs. The relevance of the spatial context is also shown by a baseline that does not consider neighbouring vessels as part of the spatial context and only reaches an accuracy of 79.4% for AIS shutdown detection.